# THE ARCHITECTURE OF MANAGING ECONOMICAL SUSTAINABILITY

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***ABSTRACT***

*Lack of courage to make unpopular decisions or disruptive changes in competitive context may result in companies finding themselves in situations where they are under threat. To react quickly and systematically, a company requires managerial mechanisms which facilitate pro-active crisis management. Here control loops may be regarded as useful management tools: immediate changes gain visibility through the periodic comparison of data. The present crisis situation shows in particular however, that systems based purely on numerical data should be used critically and not be slavishly adhered to. Otherwise a self-reinforcing corporate management system would result, which after several reporting periods would lead to the danger that it did not reflect reality: the constant attainment of cost goals, and the associated management bonuses, can generate an escalating positive feedback system, which, without external impulses, continues to exert pressure on costs, as expressed for instance, in outsourcing or other forms of cost-externalization. In order to avoid externalization effects and associated image problems, there must be internal decision mechanisms which check predefined goals against corresponding indicators such that changes can be made as required. Integrated adaptation prevents the escalating positive feedback effect.*
*The kinds and scale of goals which may be implemented in this performance-based management system, and the form the architecture of a sustainable business management may take, are described in the following section. The summary provides a synopsis of insights gained regarding such management structure and pinpoints decisions which must be made today in order to remain at the helm of a sustainable business tomorrow.*
*The paper aims to develop a frame to integrate sustainability into the decision making process. Based on empirical data and literature review the organizational architecture and some relevant key performance indicators (KPI) are designed to fulfil this integration.*

*Keywords: Sustainability, Control cycles, KPI*

## ARCHITECTURE AND INDICATORS FOR COMPANY MANAGEMENT

Managing a company holistically includes both attending to monitoring of corporate goals, and in case of excessive deviation, and attending to corresponding adaptation of the goals themselves, the associated resources or of a combination of goals and resources. Such adaptation to changing circumstances and conditions is the process step by which open-loop becomes closed-loop control. The latter is depicted in Figure 1 from the standpoint of a manufacturing or service company.
In the context of business management, the strategic target values of the company are derived from the company's vision/mission and associated with target figures. Only with these figures control loops are designed and implemented using such values, and intervention thresholds and mechanisms. This establishes what is referred to as management by exception (Staehle 1994, p. 635). In ordinary cases, management

should focus on strategic control and not engage itself in any direct operational intervention in order to maintain the self-regulatory function of the control loops (Bleicher 1995, p. 39). Only in case of external or internal signals which appear to endanger the company's given situation, are such exceptional operational directives necessary.

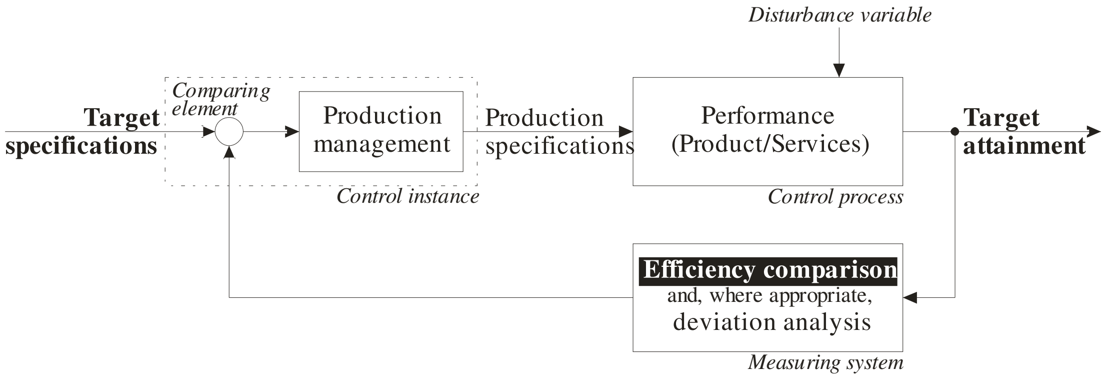


*Figure 1: Control Loop for Manufacturing Company*

These strategic control mechanisms for the entire company (Steinmann/Schreyoegg 1993, p. 221-224) are supplemented by functional and business area control loops, which in turn provide a break-down of the relevant instances. The "smallest" control loop at the end of this cascade is found in the form of employee self-monitoring, whether in production or in the office: via plausibility checks and auditing routines such as checklists, the employee audits his own performance and thereby commits to delivering acceptable performance. However, this brings with it the possibility that errors may be hidden, or improperly rectified, for example due to insufficient time or knowledge. To have a high degree of credibility in operational checks, the four-eyes principle is applied as a constituent element of sustainable company management and control. Only an independent body such as controlling, corporate audit, or quality management, is able to fully bring this principle to bear. Such neutral auditing of performance permits any self-reinforcement of indicators to be recognized at an early stage, thus facilitating corrective action. Were systematic error harboured in self-auditing, then quality control, a neutral mirror of production performance, taking place either in the factory or, in the worst case, resulting from customer complaint, would – with the help of statistical evaluations – have to filter out such employee-originated errors in order to avoid an even larger positive feedback escalation. Next to differentiation in total corporate and functional/business area control loops, the four-eyes principle is the second constituent characteristic of a corporate architecture which can be sustainably managed. External corporate controls are the third characteristic: Intrinsic corporate interests and extrinsic corporate interests can be accounted for only through external monitoring organs, since the neutrality of the third party as in the case of a controlling firm or regulatory board does not stand in any or only in a negligible conflict of interest with the company. In this way corporate as well as general economic goals can be evaluated together, so that the general utility of the company is considered in the same context as its profitability. Further, a balanced company assessment demands that the development of long-term potential be considered in addition to short-term profit prospects (Gälweiler 1987: p. 34; Abell 1999). Considering the three constituent characteristics of long-term oriented corporate control altogether, they are represented by the control loop architecture as shown in Figure 2 (see Beer 1994, p. 157; Kern 1971, p. 706; Reinhardt 2001: p. X19f), where the individual control loops from

Figure 1 are found again in the control process, which is now expanded by an auditing instance such as for example controlling.

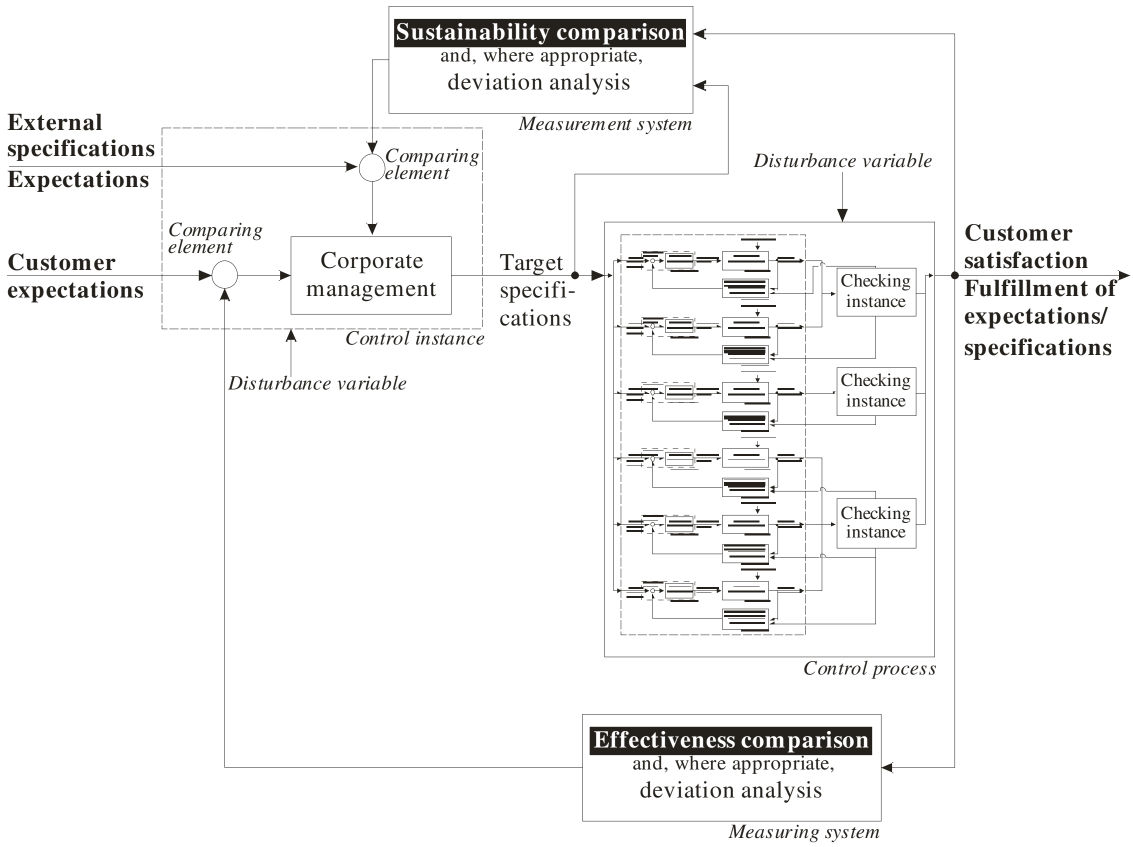


*Figure 2: Sustainable Control Loop Architecture*

Indicators which manifest sustainable corporate management are necessary to give life to this architecture and in order to "do the right things" (Drucker 1963, p. 54) without neglecting operative business processes by doing the things right (Drucker 1963, p. 54). Both levels are described using time-related as well as quality, cost and earnings-oriented indicators in order to adequately represent value creation, whether in the context of company or product value. Figure 3 shows sample indicators for sustainable corporate management, which have been extended by ethical and existence related levels, in order to account for the 4E's of sustainability (efficiency, effectiveness, ethics, and existence) to a higher degree than is ordinarily achieved through traditional performance measurement systems. The selection of the measures is dependent on the company's history and the current management focus. An empirical comparison of some automotive manufacturers is given in figure 3.

| | Efficiency | Effectiveness | Ethics | Existence |
|---|---|---|---|---|
| **Time** | * Learning-/Experience curve share<br>* Lead time<br>* Value adding time | * Product technology structure<br>* Product success share | | * Value stream destruction |
| **Quality** | * Process quality<br>* Product quality | * Total process capability | * Eco compliance<br>* Behaviour in compliance with norms<br>* Product conformance | * Operational long-term deviation |
| **Cost/ Earnings** | * Cost deviation<br>* Experience curve status | * EVA | | * MVA<br>* Company potential |

*Figure 3: The 4E-indicators for sustainable business management*

*Efficiency indicators* such as

$$\text{Process quality} = \left[\frac{\text{Production time}}{\text{Rework time} + \text{Production time}}\right] * 100 \quad [\%]$$

can be found on the short-term side, which represents the "making it right the first time" (Garvin 1988, p. 44). If there is no interference in production, the value of 100% is achieved; i.e. all products/services have been manufactured/provided already during the first process run, without rework. This figure is widely described as first pass yield or yield ratio and has gained importance in chip manufacturing, where scrap rates can be high. Product quality, which is measured via indicators, is found as a quality indicator complementing process quality. Calculating nonconformity costs as the sum of rework costs (i.e. customer complaints avoided), warranty and goodwill costs and repair costs related to parts (excluding wear-and-tear parts) provides a measure of quality as perceived by the customer and with no involvement of technical parameters. In the formula

$$\text{Product quality} = \left[1 - \frac{\text{Non - conformity cost}}{\text{Unit production cost} * \text{volume}}\right] * 100 \quad [\%]$$

the fraction's enumerator shows the nonconformity costs for the respective time period (e.g. 1 year), which is relative to the total product cost indicated in the denominator, for instance, the volume of units produced in a year times unit production cost. Focusing now on the cost leads to the next indicator,

$$\text{Cost deviation} = \left[\frac{\text{Actual cost}}{\text{Planned cost}}\right] * 100 \quad [\%].$$

With its help, the cost development within a planning period is considered. In most cases divergences result from price, quantity or mixed deviations (price and quantity vary) and the corresponding changes in costs (Kilger, Pampel and Vikas 2002, p. 135-138). Such change also results from the employee's growing experience and active learning, which enable him to respond to deviations quickly and flexibly based on his knowledge of up and down-stream areas.

$$\text{Learning - /Experience curve share} = \left[\frac{\text{Time for learning and experience sharing}}{\text{Total working time}}\right] * 100 \quad [\%]$$

Staff experience is promoted through training programs in order to achieve cost reduction effects and stimulate organizational learning. Ultimately, the efficiency of the entire organization is concerned: nominal unit costs, as derived from the experience curve (Henderson 1974), are compared to the actual situation, which provides an important indicator of efficiency. Nominal unit costs are obtained from the formula $k(M) = k_0 * (1\text{-}x)^{\log_2(M/M_0)} + k_e$ (Adam 1997, p. 480), where $k_0$ stands for the unit costs – especially labour costs in the initial situation, $M_0$ for the cumulative quantity produced in the initial situation, M for the entire cumulative quantity, and x represents the learning curve rate from 0.2 to 0.3, and $k_e$ all costs not influenced by learning.

$$\text{Experience curve status} = \left[\frac{\text{Actual unit cost}}{\text{Planned unit cost}}\right] * 100 \quad [\%],$$

where the actual unit costs are given by the inflation-adjusted costs for the reporting period. In addition to cost and quality indicators, time, as a third key target, is an essential element as it is standardized worldwide and represents processes in their original form, without allocation of indirect time units analogous to cost (for discussion of the cost allocation see Riebel 1994, p. 23-34). One of the most frequently measured dimensions of time is the lead time of an entire process chain such as a customer order or project.

$$\text{Lead time} = \sum_{i=1}^{n} \text{Time for process } i \quad [\text{time units}]$$

Here the individual process steps comprise the order flow from customer order to delivery of products or services to the customer. For the calculation, only processes are included however which are found in the critical path of material and information flow and are thus relevant in considering possible over or undershooting of deadlines. Another facet of controlling in time concerns the

$$\text{Value adding time} = \left[\frac{\sum_{j=1}^{m} \text{Direct value adding time of process } j}{\text{Total process time}}\right] * 100 \quad [\%],$$

which encapsulates all processes for e.g. order processing. In particular, high idle and unproductive moments have a detrimental effect on the goal of approximating the 100% ideal.

*Ethical indicators* deal with ethical values, normative compliance, or generally, with proper moral behaviour (Paine 2003, p. 2). These ethical standards are manifest in behavioural guidelines, regulations or laws, which in turn form the basis for the definition of indicators. Since every company as well as its individual products are embedded in the environment, eco compliance is considered as the first indicator:

$$\text{Eco compliance} = \frac{\sum_{i=1}^{n} \text{Environmental norm } i * \text{Duration of compliance to norm } i}{\text{Total amount of environmental norms} * \text{Total duration time}}$$

Compliance with emission and ambient pollution regulations in relation to water, soil and air is necessary for the long-term survival of the company. By including the duration of compliance with each performance standard, emphasis is placed on an as continuous a performance as possible. The total duration is usually derived from reporting, which takes place either semi-annually or annually. The second ethical indicator expresses personal observance of norms:

$$\text{Behaviour in compliance with norms} = \frac{\sum_{k=1}^{m} \text{Norm k} * \text{Duration of compliance to norm k}}{\text{Total number of norms} * \text{Total duration time}}.$$

This performance indicator shows whether within a company there is success in exemplifying normative compliance, and thus, in presenting the company as a "good neighbour" who does not impair the social climate through norm violations. Such norms include, for example, social laws, anti-corruption laws, tax laws, business conduct guidelines ("do's and don'ts"), or cultural-religious traditions and customs. The third ethical code brings product quality to the fore, because poor performance in any cultural context is negatively sanctioned, and any product or service delivered must thus comply to the ethical demand of absence of defects. With the parameter

$$\text{Product conformance} = \left[\frac{\text{Number of defective products}}{\text{Total number of sold products}}\right] * 1.000.000 \quad [\text{dpm}],$$

customer satisfaction is expressed in terms of defects per million products (dpm). The formula is applied to a period of observation equalling the life cycle of the product. This indicator has a target value of zero and an upper tolerance limit of 500 in order to differentiate very good products from lesser ones.
The three ethical indicators focus on legally or qualitatively perceptible misconduct in business-related context. There are also gaps between law and ethos, so that not all ethical action is explicitly addressed by laws (Kueng 1998, p. 141-147). Ethical obligations such as duties of conscience or humanitarian obligations cannot be imposed, but are rather subject to intrinsic moral obligations, and therefore are neither verifiable, nor enforceable. Therefore, ethical indicators also have intrinsic boundaries.

Indicators regarding effectiveness and existence levels are found on the long-term side of sustainable business management. The learning curve is one of the dimensions of *effectiveness*, which, in conjunction with the technology-oriented S-curve (Foster, 1986), reflects the technological structure of the company: the learning curve emerging from the past, and the S-curve corresponding to prognoses regarding future technology potential. This yields the indicator for the company's product technology structure:

$$\text{Product technology structure} = \left[\frac{\sum_{i=1}^{n} \text{Technology i with future potential}}{\sum_{j=1}^{m} \text{Technology component j}}\right] * 100 \quad [\%].$$

The total number of technologies is determined by splitting the product into the individual components which serve as technology carriers. These carriers are analyzed to determine whether they are to be ascribed to basic, key, or pacemaker technologies (Servatius 1985, p. 116ff.). In case of use of key or pacemaker technologies, their future application fields, derived from the S-curve, are considered to permit predictions regarding output increase of the respective components. In case of disproportionately high output increase, the respective technology is considered as one with future potential. The extent to which defect-free product technologies can be created through complementary process technologies, and processed by qualified personnel, is indicated by

$$\text{Total process capability } c_{pk} = \text{Employee capability } c_{pk} * \text{Process capability } c_{pk}$$

whereby the respective capability indicators are represented as $c_{pk}$ values: these two individual indicators are determined through statistical calculations regarding machine capabilities and employee capabilities (Bhote and Bhote 2000, p. 51-64).

For the positioning of ideally error-free products, the market growth/market share portfolio (Oettinger 2000, p. 339 and Henderson 2000, p. 346) is used. This diagnostic tool indicates the relevant cash cows, stars, question marks and black holes relevant for the company's market survival, and what possible changes may be inferred in order to favourably shape the future. The portfolio is framed by two dimensions, namely market growth (volume) and relative market share. In order to measure the effectiveness here, a company must set the share of its stars and cash cows in relation to the total number of its products, so that the relative share of the company's success products is immediately visible, and is not obscured by turnover data.

$$\text{Product success share} = \frac{\sum(\text{Stars} + \text{Cash cows})}{\sum(\text{Stars} + \text{Cash cows} + \text{Question marks} + \text{Black holes})} * 100 \quad [\%]$$

with the assumed time period spanning the next 3-5 years. To measure the economic attractiveness of the product portfolio, surplus profit is used. The calculated value added based upon such profit is expressed by

$$\text{Economic Value Added (EVA)} = \left[\frac{\text{NOPAT}_t}{\text{Capital investment}_t} - \text{WACC}\right] * \text{Capital investment}_t$$

where t represents time, NOPAT the <u>n</u>et <u>o</u>perating <u>p</u>rofit <u>a</u>fter <u>t</u>axes, and WACC (<u>w</u>eighted <u>a</u>verage <u>c</u>ost of <u>c</u>apital) represents the average total capital costs (Coenenberg and Salfeld 2003, p. 266). The EVA approach enables a company to evaluate products based upon their intrinsic value such that products are not only analysed in terms of their position in the relative market share/market growth portfolio but also with regard to their intrinsic value (value creation/value destruction) (Hermann, Xhonneux and Groth 2003, p. 405).

In the context of value-oriented management, the long-term *existence* of the company can also be evaluated. Ideally, the company's long-term perspective comprises minimally 5-10 and maximally several generations of mankind. Using

$$\text{Market Value Added (MVA)} = \sum_{t=1}^{\infty} \frac{\text{EVA}_t}{(1+\text{WACC})^t} + \text{Capital investment}_{t=0}$$

the EVA approach is further developed to a total company market value added (MVA) (Coenenberg and Salfeld 2003, p. 267). By focusing on the entire company, strategic fragmentation in individual business areas is avoided and the company's development is depicted in a holistic manner. This reflects the relationship between future product potentials, i.e. those that become manifest in three or more years from today and current product successes (≤ 3 years). Both of these are expressed in terms of discounted cash flow (DCF).

$$\text{Company potential} = \frac{\text{DCF}_{\text{Product potentials} > 3 \text{ years}}}{\text{DCF}_{\text{Product successes} \leq 3 \text{ years}}}$$

Ideally, this indicator oscillates around a factor of 1: in times of a successful product range with great future product innovations, this value should be > 1 in order to be able to afford consolidation phases having ratios with a value < 1. It is precisely in this oscillatory movement that the law of relaxation is expressed, which is demonstrated in biological control loops as positive and negative feedback (Vester 1991, p. 58-63): In the long term, a system which stands under constant stress cannot survive. Such rest periods are therefore deliberately scheduled. In the long-term it is necessary to maintain the value in excess of 1 in order to generate an economical rent. Such a rent can be achieved either based upon natural resources (Ricardo) or on the basis of technological advantage (Schumpeter). Thirdly, the development of costs and earnings, processing time and quality indicators are retrospectively considered over a period of ≥ 5 years in order to obtain a plan/actual comparison. Actions are to be inferred from the deviations in order to avoid such gaps in the future by “doing the right things” (Drucker 1963, p. 54).

$$\text{Operational long - term deviation} = \frac{\text{Actual figures}_{\text{Quality, Time, Cost/Earnings}}}{\text{Planned figures}_{\text{Quality, Time, Cost/Earnings}}}$$

The long-term figures should also oscillate around the factor of 1; however they should do so with minimum scatter to indicate a high degree of quality in planning and execution.

However the long-term operational target should be around 1 the creative destruction (Schumpeter ) of existing value streams is one of the major goals for a Kondratieff-orientated company outlook. Therefore the

$$\text{Value stream destruction} = \frac{\text{Number of decomposed value streams}}{\text{Total number of value streams}}$$

illustrates the company’s internal capability to destroy its own value stream before competitive forces are driving the company into the decomposition. Managed in a timely manner this destruction can help companies to manage particularly long-term issues like technology or organisational/behavioural changes.

Thus, the 4E indicators have been outlined in their basic structure. For individual companies they may be supplemented by one or two additional indicators. Monitoring all indicators in concert makes it possible to manage a business successfully over the long term. Figure 4 shows the links between the different KPIs in the four different views of the balanced scorecard (Kaplan and Norton 1996, p. 255).

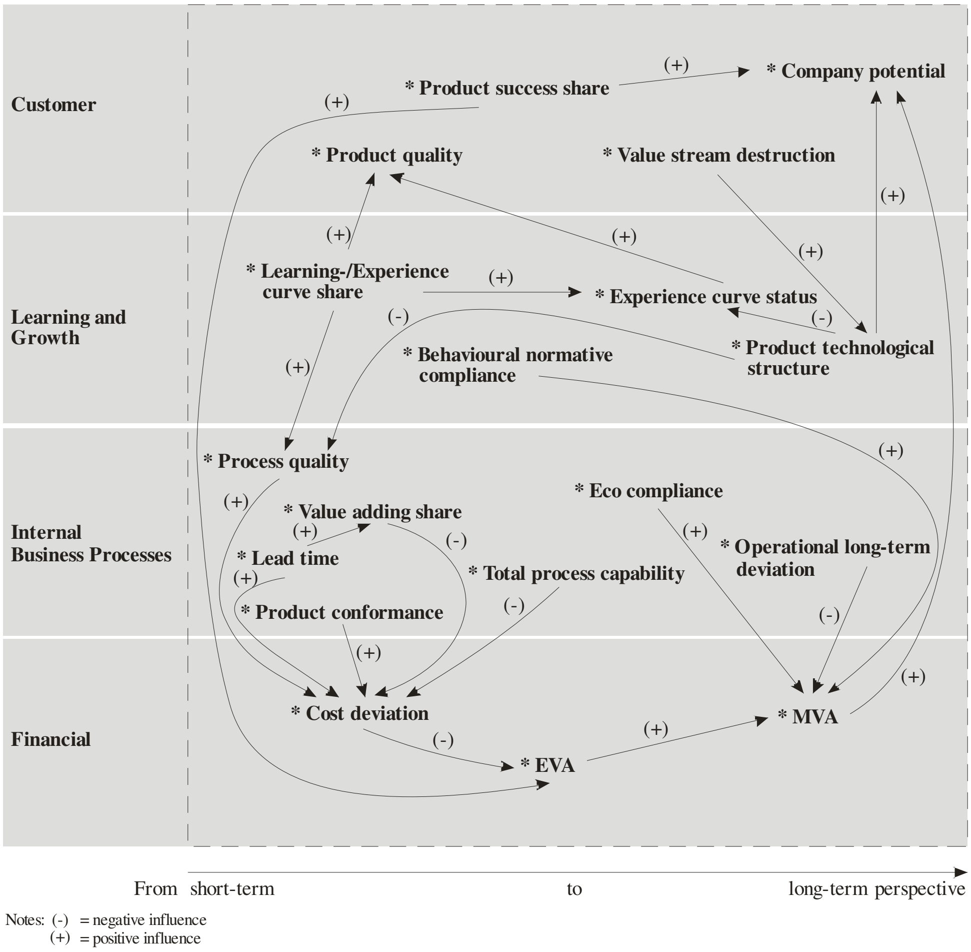


*Figure 4: The 4E-indicators with their exemplified links*

## CONCLUSION

Despite the use of control loop architecture and a corporate management which aims both at corporate survival and the common good, the situation may arise where a company can no longer survive. In order to avoid such extreme situations, monitoring bodies are required, which, in economically good times, are already charged with the task of testing the resiliency of a company in the event of sudden changes through stress tests. If the stress test is passed, then no stabilizing preventive measures are necessary; otherwise, the company must establish appropriate control loops, parameters and resources, in order to pass a new stress test.
To achieve such stability during change, however, decisions must be made today on two levels: First, an auditing instance (= external measuring system) must be determined which carries out the stress test and evaluates the company. Possibilities here include state supervisory bodies such as the Bundesanstalt für Finanzdienstleistungsaufsicht (BaFin), technical monitoring bodies such as TÜV or Dekra, institutions of the European Union or the World Trade Organization (WTO), which, similarly to accounting firms, could issue attestations which formally certify the ability of the company to smoothly manage change under stress conditions. On the other hand, the extent to which the company's use of performance indicators is to be adapted must be decided. To prevent an escalating deviation of indicators, ideally the performance measurement system will be reinvented after 3-5 years thus shifting the focus between the 4E-indicators. Special emphasis must be placed here on finding new parameters to measure efficiency. For example, the current cost-orientation will become subordinate

when organizing a time-driven company in the next few years (Kuhn 1996). Hierarchies of goals are newly established, and target values are re-defined through this conscious change, so that a new starting point for target values and their optimization in forthcoming years is created.

Further requirements in research context concern the lacuna which have emerged regarding ethical and existence indicators at the level of time and quality. The use of these indicators and their combination in efficiency and effectiveness ratios are relatively uncharted territory in indicator-driven management, which remains strongly oriented towards traditional cost calculations.

In order to remain at the apex tomorrow, corporate management can demonstrate its ability to manage change only through active structuring of control mechanisms and conscious adaptation of performance indicators today.

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View Economic Sustainability Research Papers on Academia.edu for free.Â  Part II then presents a comparative literature review on the evolution of environmental, social, and economic sustainability norms in the texts of the agreements. In so doing, it confirms the evolutionary paths identified in Part I, finding: 1) that norms and provisions related to Sustainable Development have expanded in both scope and reach; and 2) that the analytical exercises that in some instances are run in parallel with the negotiation of free trade agreements â€“ the so-Ââ€ called sustainability impact assessments and the like â€“ also have become more. Sustainable architecture is a general term that describes environmentally conscious design techniques in the field of architecture. Sustainable architecture is framed by the larger discussion of sustainability and the pressing economic and political issues of our world. In the broad context, sustainable architecture seeks to minimize the negative environmental impact of buildings by enhancing efficiency and moderation in the use of materials, energy, and development space. Most simply, the idea of Three Dimensions-sustainable architecture. Environmental Sustainability Architecture. The idea of environmental sustainability is to leave the Earth in as good or better shape for future generations than we found it for ourselves. By a definition, human activity is only environmentally sustainable when it can be performed or maintained indefinitely without depleting natural resources or degrading the natural environment.Â  Sustainable construction is defined as â€œthe creation and responsible management of a healthy built environment based on resource efficient and ecological principlesâ€œ. Sustainably designed buildings aim to lessen their impact on our environment through energy and resource efficiency. It includes the following principles